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REC'D 28 JAN 2000

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PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70) ~~09/16~~ 09/463.446

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
P1737-WO		

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB98/02823	17/09/1998	17/09/1997

International Patent Classification (IPC) or national classification and IPC
G09B9/12

Applicant
Linear Motion Technology LLC et al

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 9 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 5 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☒ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
14/04/1999	26.01.00

Name and mailing address of the international preliminary examining authority:
European Patent Office
D-80298 Munich
Tel. +49 89 2399 - 0 Tx: 523656 epmu d
Fax: +49 89 2399 - 4465

Authorized officer
Watson, S
Telephone No. +49 89 2399 2840

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB98/02823

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

1-38 as originally filed

Claims, No.:

1-17 with telefax of 10/12/1999

Drawings, sheets:

1/15-15/15 as originally filed

2. The amendments have resulted in the cancellation of:

☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

☐ restricted the claims.

☐ paid additional fees.

☐ paid additional fees under protest.

☒ neither restricted nor paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

   ☐ complied with.

   ☒ not complied with for the following reasons:

   see separate sheet

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

   ☐ all parts.

   ☒ the parts relating to claims Nos. 1-13.

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-13
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-13
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-13
	No:	Claims	

2. Citations and explanations

   see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

IV Lack of Unity

Reference is made to the following documents:

D1: Engstrand B: 'Pneumatics: A force beyond virtual reality' Hydraulics and Pneumatics, vol. 49, no. 7, 1 July 1996, pages 35-38, XP000595310

The application lacks unity within the meaning of Rule 13 PCT for the following reasons:
The common concept linking together independent claims 1, 9, 14 and 16 is the following:
An apparatus comprising means for applying a perturbing force to a load (actuators) and (compliant) means for supporting the load (weight of the platform).

This common concept is not novel, see document D1, page 37-38, sections headed, "Compliance and hardware" and, "Basic hardware", these describe the use of pneumatic cylinders to provide perturbing forces and valves which in conjunction with the compressed air in the cylinders provides the compliant means for supporting the load, see also page 35, second column, first paragraph.

Hence the Examining Division considers that the following separate inventions or groups of inventions are not so linked as to form a single general inventive concept:

1 **Claims 1-13:** Apparatus for imparting motion to a load and for controlling relative motion in a plurality of degrees of freedom between a platform and a reference plane, comprising independent actuating and compliant support means and means of varying the compliant support.

2 **Claims 14-15:** Apparatus for controlling relative motion in a plurality of degrees of freedom between a platform and a reference plane, wherein the support means are each associated with an actuator.

3 **Claims 16-17:** Apparatus for controlling relative movement in a plurality of degrees of freedom between a platform and a reference plane,

wherein restraint means are provided for preventing unwanted movement of the motion platform.

As no reply was received to the invitation to restrict the application or pay additional fees, this report is drawn up for claims 1-13 only.

VIII Certain observations on the international application

1 The subject-matter of claim 1 is unclear (Article 6 PCT).
It is clear from the description (page 5, last paragraph - page 6, first paragraph) that the compliant support means act to store *and* deliver energy from *and* to the load. In claim 1 the compliant support means are described as acting to store *or* deliver energy from *or* to the load, this implies the compliant support means either provide energy transfer to the load or from the load, but not both. This implies that an apparatus comprising compliant support means providing constant support during operation includes this feature.

For the purposes of the statement under Article 35(2) (see point V below), this feature is interpreted as meaning the compliant support means act to store and deliver energy to and from the load.

2 Claim 1 does not meet the requirements of Article 6 PCT in that the matter for which protection is sought is not clearly defined. The claim attempts to define the subject-matter in terms of the result to be achieved which merely amounts to a statement of the underlying problem. The technical features necessary for achieving this result should be added.

3 The embodiments of the invention described on pages 8-12, 21-26 and shown in figures 1 and 2 do not fall within the scope of the claims. This inconsistency between the claims and the description leads to doubt concerning the matter for which protection is sought, thereby rendering the claims unclear (Article 6 PCT).

4 The subject-matter of claim 12 is rendered unclear by the phrase, "modified by changing the mean of gas".

V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1.1 The subject-matter of claim 1 is considered to be novel (Article 33(2) PCT) as none of the available prior art shows an apparatus for imparting motion to a load comprising independent actuating and compliant support means wherein the compliance of the compliant support means can be varied during operation to store energy from and deliver energy to the load.

1.2 Document D1, which is considered to represent the closest prior art, describes an apparatus for imparting motion to a load comprising means for providing compliant support to the load and for applying forces to the load. The subject-matter of claim 1 differs from this known apparatus in that it contains the additional features that the compliant support means acts independently of the means for applying forces to the load to store or deliver energy to or from the load and the apparatus further comprises means for varying the compliance of the compliant support means during operation.

The problem to be solved by the above invention is to minimise the power consumption of the apparatus.

The solution given in the subject-matter of claim 1 is considered to be inventive (Article 33(3) PCT) as it is not known or obvious from the available prior art to provide independent, operationally variable compliant support means which can be varied in order to store or deliver energy from or to the load, thereby reducing the amount of power needed for the means for applying forces to the load.

Document WO 93/01577 (D2) shows a system with compliant support means, however this system only supports the load and cannot deliver energy to and from the load.

2 Claims 2-8 are dependent on claim 1 and as such also fulfil the requirements of the PCT with regard to novelty and inventive step.

3.1 The subject-matter of claim 9 is considered to be novel (Article 33(2) PCT) as none of the available prior art shows an apparatus for controlling relative motion in

a plurality of degrees of freedom, with one or more actuators and compliant support means, wherein the compliance can be dynamically varied in a manner related to the forces applied by the actuator means and in order to modify these forces.

3.2 Document EP 0 761 266 (D3) is regarded as being the closest prior art. This document shows an apparatus for controlling relative motion in a plurality of degrees of freedom between a platform and a reference plane (see abstract, col. 4, line 51-col. 5, line 38 and figures 5-7), comprising compliant means for supporting the weight of the platform (fig 5 (21)), one or more actuators for applying perturbing forces between the platform and the reference plane (col. 5, lines 3-14), and control means for controlling the actuator to move in one direction or the other whereby to displace the platform with respect to the reference plane (col. 5, lines 32-38).

The subject-matter of D1 differs from this known apparatus in that the compliance of the compliant support means is dynamically varied in a manner related to the perturbing force applied to the load.

The problem to be solved is regarded as being to minimise the power consumption of the apparatus.

The solution proposed in claim 9 is regarded as being inventive as the available prior art does not disclose or hint at the use of dynamically varying the compliance to modify the required forces and save power consumption.

4 Claims 10-13 are dependent on claim 9 and as such also meet the requirements of the PCT with regard to novelty and inventive step.

VII Certain defects in the international application

1 The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

2 Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the documents D1 and D3 is not mentioned in the description, nor are these documents identified therein.

CLAIMS

1. Apparatus for imparting motion to a load comprising means for providing compliant support to the load and for applying forces to the load whereby to cause the position thereof to change characterised in that the means for applying forces to the load act independently of the said compliant support means to apply perturbing forces to the load, in that the compliant support means acts to store or deliver energy from or to the load as a consequence of motion imparted thereto by the said means for applying perturbing forces, and in that means for varying the compliance of the said compliant support means are provided, operable to vary the said compliance during operation of the apparatus together with or separately from the operation of the said means for applying perturbing forces to the load.

2. Apparatus according to Claim 1, in which the said means for applying forces to the load comprise an actuator having at least one degree of freedom, operative to apply an intermittent perturbing force to the said load whereby to cause displacement thereof, and the compliant support is capable of applying a force to the said load in addition to the said intermittent perturbing force, the means for varying the compliance of the said compliant support means being controlled to act in a manner related to the force applied to the load whereby

to cooperate actively in the displacement thereof.

3. Apparatus according to Claim 1 or Claim 2, in which the means for applying the perturbing force is an electromagnetic actuator.

4. Apparatus according to Claim 3, in which the actuator is a linear electromagnetic actuator.

5. Apparatus according to Claim 3 or Claim 4, in which the variation in compliance is controlled in dependence on the electrical current required to accelerate the load.

6. Apparatus according to any of Claims 3 to 5, in which the variation in compliance is controlled by signals generated as an integral of a position error signal applied to the electromagnetic actuator.

7. Apparatus according to any of Claims 1 to 6, in which at least part of the compliant means is a gas spring and the variation in compliance is achieved by varying the mass of gas contained within a chamber of variable volume.

8. Apparatus according to Claim 7, in which at least part of the compliant means is a gas spring and the variation in compliance is achieved by controlling valves

which allow gas into and/or out from the said chamber.

9. Apparatus for controlling relative motion in a plurality of degrees of freedom between a platform and a reference plane, comprises compliant means for supporting the weight of a platform, one or more actuators for applying perturbing forces between the platform and the reference plane, and control means for controlling the or each actuator to move in one direction or the other whereby to displace the platform with respect to the reference plane, characterised in that the compliance of the compliant support means is variable, and there are provided means for dynamically varying the compliance thereof in a manner related to the perturbing forces applied to the load by the actuator means whereby to modify the said forces.

10. Apparatus according to Claim 9, in which the actuators have pivotal connections to the part of the apparatus defining the fixed reference plane, whereby each actuator is constrained to turn about the pivotal connection within a respective plane.

11. Apparatus according to Claim 9 or Claim 10, in which a supporting member is connected with universal freedom between the motion platform and the said reference plane.

12. Apparatus according to Claim 11, in which the

compliance of the said compliant support means is modified by changing the mean of gas enclosed within a fas spring element.

13. Apparatus according to Claim 12, in which the inclination between the actuators and the horizontal plane with the motion platform at a rest position is approximately 45°.

14. Apparatus for controlling relative motion in a plurality of degrees of freedom between a motion platform and a reference plane, comprising means for supporting the weight of the motion platform, one or more actuators for applying perturbing forces between the platform and the reference plane, and control means for controlling the or each actuator whereby to vary the position and/or orientation of the platform with respect to the reference plane, characterised in that the means for supporting the weight of the motion platform comprise respective compliant support members each associated with a respective said actuator.

15. Apparatus according to Claim 14, in which the ratio between the diameter of the circumscribing circle around the points of attachment of the ends of the actuators to the motion platform with respect to the diameter of the circumscribing circle around the points of attachment around the ends of the actuators to the part of the

apparatus defining the reference plane is in the region of 1:1.5.

16. Apparatus for controlling relative movement in a plurality of degrees of freedom between a motion platform and a reference plane, comprising compliant means for supporting the weight of a platform, one or more actuators for applying a perturbing force between the platform and the reference plane, and control means for controlling the or each actuator to vary the position and/or orientation of the platform with respect to the reference plane by operation of the actuators, in which there is further provided restraint means for preventing movement of the motion platform in relation to the reference plane in unwanted degrees of freedom.

17. Apparatus according to Claim 16, in which the said restraint mechanism comprises or includes a bellows unit.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), t : Mail Mail Stop ISSUE FEE
Commissioner for Patents
Alexandria, Virginia 22313-1450
Fax (703)746-4000

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 4 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Legibly mark-up with any corrections or use Block 1)

24113 7590 06/17/2003

PATTERSON, THUENTE, SKAAR & CHRISTENSEN, P.A.
4800 IDS CENTER
80 SOUTH 8TH STREET
MINNEAPOLIS, MN 55402-2100

OIPE JC102 JUL 24 2003 PATENT & TRADEMARK OFFICE

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Box Issue Fee address above, or being facsimile transmitted to the USPTO, on the date indicated below.

JAMES M. PARSLEY	(Depositor's name)
	(Signature)
07/22/03	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/763,446	07/09/2001	Terje Eidesmo	1101.99USO1	6268

TITLE OF INVENTION: METHOD AND APPARATUS FOR DETERMINGING THE CONTENT OF SUBTERRANEAN RESERVOIRS

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1300	$0	$1300	09/17/2003

EXAMINER	ART UNIT	CLASS-SUBCLASS
PATIDAR, JAY M	2862	324-337000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list (1) the names of up to 3 registered patent attorneys or agents OR, alternatively, (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Patterson, Thuente, Skaar & Christensen, P.A.
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. Inclusion of assignee data is only appropriate when an assignment has been previously submitted to the USPTO or is being submitted under separate cover. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: Den Norske Stats Oljeselskap A.S.

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Stavanger, Norway

Please check the appropriate assignee category or categories (will not be printed on the patent) ☐ individual XX corporation or other private group entity ☐ government

4a. The following fee(s) are enclosed:

☒ Issue Fee

☐ Publication Fee

☒ Advance Order - # of Copies 10

4b. Payment of Fee(s):

☒ A check in the amount of the fee(s) is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☒ The Commissioner is hereby authorized by charge the required fee(s), or credit any overpayment, to Deposit Account Number 16-0631 (enclose an extra copy of this form).

Commissioner for Patents is requested to apply the Issue Fee and Publication Fee (if any) or to re-apply any previously paid issue fee to the application identified above.

(Authorized Signature) _____ (Date) 07/22/03

NOTE; The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

07/23/2003 MMEDE 00000214 09763446

01 FC:1301 1300.00 DP
02 FC:1501 30.00 DP

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, Alexandria, Virginia 22313-1450.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TRANSMIT THIS FORM WITH FEE(S)

Form PTO-1390 (Rev. 10-97) U.S. Department of Commerce Patent and Trademark Office	ATTORNEY'S DOCKET NO.
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371	1101.99US01
	US APPLICATION NO. (If known, see 37 CFR 1.5) 09/763446

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/GB99/02823	26 August 1999	28 August ~~1999~~ 1998

TITLE OF THE INVENTION

METHOD AND APPARATUS FOR DETERMINING THE NATURE OF SUBTERRANEAN RESERVOIRS

APPLICANT(S) FOR DO/EO/US

Terge EIDESMO, Svein ELLINGSRUD, Fan-Nian KONG, Harald WESTERDAHL, Stale JOHANSEN

Applicant hereby submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is the **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This express request to begin national examination procedures (35 U.S.C. 371 (f)) at any time rather than delay examination until the expiration of the applicable time limits set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.

d. ☒ have not been made.

8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4).
10. ☒ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5).

Items 11. to 16. below concern document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
    ☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information: International Search Report and Preliminary Examination Report, (Cited references are with the attached PTO 1449), Front Page of PCT Published Application, and Return Postcard

17. ☒ The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1)-(5)

Search Report has been prepared by the EPO or JPO.....**$860.00**

International preliminary examination fee paid to USPTO (37 CFR 1.482).....**$690.00**

No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee (37 CFR 1.445(a)(2)) paid to USPTO.....**$710.00**

Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO.....**$1,000.00**

International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4).....**$100.00**

	CALCULATIONS (PTO USE ONLY)	
ENTER APPROPRIATE BASIC FEE AMOUNT =	**$860.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e))	**$0.00**	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	23 - 20 =	3	X $18.00	**$54.00**	
Independent claims	2 - 3 =	0	X $80.00	**$0.00**	
Multiple Dependent Claim(s) (If applicable)			X $270.00	**$0.00**	
			TOTAL OF ABOVE CALCULATIONS =	**$914.00**	

09/763446
JC03 Rec'd PCT/PTO 22 FEB 2001

Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28)	$	
SUBTOTAL =	**$914.00**	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +	**$0.00**	
TOTAL NATIONAL FEE =	**$914.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +	$	
TOTAL FEES ENCLOSED =	**$914.00**	
	Amount to be: refunded	$
	charged	$

a. ☒ A check in the amount of $914.00 to cover the above fees is enclosed

b. ☐ Please charge my Deposit Account No. **16-0631** in the amount of $ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 16-0631. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

John F. THUENTE
Patterson, Thuente, Skaar & Christensen, P.A.
4800 IDS Center
80 South Eighth Street
Minneapolis, MN 55402-2100

(612) 349-5747 Telephone
(612) 349-9266 Facsimile

Signature

John F. Thuente
Name

29,595
Registration Number

February 22, 2001
Date

PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the application of: Attorney Docket No.: 1101.99US01

Eidesmo et al.

Application No.: Based on PCT Application No. PCT/GB99/02823

Filed: February 22, 2001

For: METHOD AND APPARATUS FOR DETERMINING THE NATURE OF SUBTERRANEAN RESERVOIRS

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to examination, please amend the above-identified application as follows:

In the Claims

Please cancel claims 1-22 without prejudice or disclaimer.

Please add new claims 23-45 as follows:

23. A method of determining the nature of a submarine or subterranean reservoir whose approximate geometry and location are known, which comprises:

applying a time varying electromagnetic field to the strata containing the reservoir; detecting the electromagnetic wave field response; and analysing the effects on the characteristics of the detected field that have been caused by the reservoir, thereby determining the content of the reservoir, based on the analysis.

24. The method as claimed in claim 23, wherein the field is applied using at least one stationary transmitter located on the earth's surface.

25. The method as claimed in claim 24, wherein the at least one transmitter is located proximate a bed of a body of water, the bed including a seabed.

26. The method as claimed in claim 23, wherein the detection is carried out by at least one stationary receiver located on the earth's surface.

27. The method as claimed in claim 24, wherein the at least one receiver is located proximate a bed of a body of water, the bed including a seabed.

28. The method as claimed in claim 23, wherein the transmitted field is in the form of a wave.

29. The method as claimed in claim 23, wherein the field is transmitted for a period of time of from 30 seconds to 60 minutes.

30. The method as claimed in claim 23, wherein the field is transmitted for a period of time of from 3 minutes to 30 minutes.

31. The method as claimed in claim 26, in which the receivers are arranged to detect a direct wave and a wave reflected form the reservoir, and the analysis includes extracting phase and amplitude data of the reflected wave from corresponding data from the direct wave.

32. The method as claimed in claim 28, wherein the wavelength of the transmitted wave is given by the formula

$$0.1s \leq \lambda \leq 10s;$$

where λ is the wavelength of the transmission through an overburden overlying a reservoir and s is the distance from a seabed to the reservoir.

33. The method as claimed in claim 28, wherein a distance between a transmitter and a receiver is given by the formula

$$0.5\,\lambda \leq 1 \leq 10\,\lambda;$$

where λ is the wavelength of the transmission through an overburden and 1 is the distance between the transmitter and the receiver.

34. The method as clamed in claim 33, in which, substantially,

$$1 = 2s - 2\lambda.$$

35. The method as claimed in claim 23, wherein the transmission frequency of the time varying electromagnetic field is from 0.1 Hz to 1 kHz.

36. The method as claimed in claim 35, wherein the transmission frequency of the time varying electromagnetic field is from 1 to 50 Hz.

37. The method as claimed in claim 23, in which a first transmission by at least one transmitter is made at a first frequency and is received by each receiver in a tuned array of receivers, then a second transmission is made at a second frequency and received by the same tune array of receivers, the receivers being tuned to receive their respective transmission, the at least one transmitter being tuned for optimum transmission.

38. The method as claimed in claim 23, wherein the analysis includes comparing the results of measurements taken with results of a mathematical simulation model based on known properties of the reservoir and conditions of an overburden.

39. The method as claimed in claim 28, including suppressing a direct wave, thereby reducing the required dynamic range of receivers receiving a reflected wave and increasing resolution of the reflected wave.

40. Apparatus for determining the nature of a subterranean reservoir having a content, the approximate geometry and location of the subterranean reservoir being known, comprising:

means for applying a time varying electromagnetic field to the strata containing the reservoir; means for detecting the electromagnetic wave field response; and

means for analyzing the effects on the detected field that have been caused by the reservoir, thereby enabling the content of the reservoir to be determined based on the analysis.

41. Apparatus as claimed in claim 40, wherein the means for applying the field comprises at least one transmitter and the means for detecting the field comprises an array of receivers.

42. Apparatus as claimed in claim 41, in which the transmitter and receivers comprise dipole antennae or coils.

43. Apparatus as claimed in claim 41, wherein a plurality of transmitters are employed.

44. Apparatus as claimed in claim 40, in which the analysing means is arranged to analyze phase and amplitude.

45. The method of claim 23 including as preliminary steps; performing a seismic survey to determine the geological structure of a region and analyzing the survey to reveal the presence of a subterranean reservoir.

Remarks

By this Amendment, claims 1-22 are canceled and new claims 23-45 are added.

In view of the foregoing, it is submitted that this application is in condition for allowance. Favorable consideration and prompt allowance of the application are respectfully requested.

The Examiner is invited to telephone the undersigned if the Examiner believes it would be useful to advance prosecution.

Respectfully submitted,

John F. Thuente
Registration No. 29,595

Customer No. 24113
Patterson, Thuente, Skaar & Christensen, P.A.
4800 IDS Center
80 South 8th Street
Minneapolis, Minnesota 55402-2100
Telephone: (612) 349-5747

ATTACHMENT
REDLINED AMENDMENT

Claims As Amended

Please cancel claims 1-22 without prejudice or disclaimer.

Please add new claims 23-45 as follows:

23. A method of determining the nature of a submarine or subterranean reservoir whose approximate geometry and location are known, which comprises:

applying a time varying electromagnetic field to the strata containing the reservoir; detecting the electromagnetic wave field response; and analysing the effects on the characteristics of the detected field that have been caused by the reservoir, thereby determining the content of the reservoir, based on the analysis.

24. The method as claimed in claim 23, wherein the field is applied using at least one stationary transmitter located on the earth's surface.

25. The method as claimed in claim 24, wherein the at least one transmitter is located proximate a bed of a body of water, the bed including a seabed.

26. The method as claimed in claim 23, wherein the detection is carried out by at least one stationary receiver located on the earth's surface.

27. The method as claimed in claim 24, wherein the at least one receiver is located proximate a bed of a body of water, the bed including a seabed.

28. The method as claimed in claim 23, wherein the transmitted field is in the form of a wave.

29. The method as claimed in claim 23, wherein the field is transmitted for a period of time of from 30 seconds to 60 minutes.

30. The method as claimed in claim 23, wherein the field is transmitted for a period of time of from 3 minutes to 30 minutes.

31. The method as claimed in claim 26, in which the receivers are arranged to detect a direct wave and a wave reflected form the reservoir, and the analysis includes extracting phase and amplitude data of the reflected wave from corresponding data from the direct wave.

32. The method as claimed in claim 28, wherein the wavelength of the transmitted wave is given by the formula

$$0.1s \leq \lambda \leq 10s;$$

where λ is the wavelength of the transmission through an overburden overlying a reservoir and s is the distance from a seabed to the reservoir.

33. The method as claimed in claim 28, wherein a distance between a transmitter and a receiver is given by the formula

$$0.5\,\lambda \leq 1 \leq 10\,\lambda;$$

where λ is the wavelength of the transmission through an overburden and 1 is the distance between the transmitter and the receiver.

34. The method as clamed in claim 33, in which, substantially,

$$1 = 2s - 2\lambda.$$

35. The method as claimed in claim 23, wherein the transmission frequency of the time varying electromagnetic field is from 0.1 Hz to 1 kHz.

36. The method as claimed in claim 35, wherein the transmission frequency of the time varying electromagnetic field is from 1 to 50 Hz.

37. The method as claimed in claim 23, in which a first transmission by at least one transmitter is made at a first frequency and is received by each receiver in a tuned array of receivers, then a second transmission is made at a second frequency and received by the same tune array of receivers, the receivers being tuned to receive their respective transmission, the at least one transmitter being tuned for optimum transmission.

38. The method as claimed in claim 23, wherein the analysis includes comparing the results of measurements taken with results of a mathematical simulation model based on known properties of the reservoir and conditions of an overburden.

39. The method as claimed in claim 28, including suppressing a direct wave, thereby reducing the required dynamic range of receivers receiving a reflected wave and increasing resolution of the reflected wave.

40. Apparatus for determining the nature of a subterranean reservoir having a content, the approximate geometry and location of the subterranean reservoir being known, comprising:

means for applying a time varying electromagnetic field to the strata containing the reservoir; means for detecting the electromagnetic wave field response; and

means for analyzing the effects on the detected field that have been caused by the reservoir, thereby enabling the content of the reservoir to be determined based on the analysis.

41. Apparatus as claimed in claim 40, wherein the means for applying the field comprises at least one transmitter and the means for detecting the field comprises an array of receivers.

42. Apparatus as claimed in claim 41, in which the transmitter and receivers comprise dipole antennae or coils.

43. Apparatus as claimed in claim 41, wherein a plurality of transmitters are employed.

44. Apparatus as claimed in claim 40, in which the analysing means is arranged to analyze phase and amplitude.

45. The method of claim 23 including as preliminary steps; performing a seismic survey to determine the geological structure of a region and analyzing the survey to reveal the presence of a subterranean reservoir.

Method and Apparatus for Determining the Nature of Subterranean Reservoirs

The present invention relates to a method and apparatus for determining the nature of submarine and subterranean reservoirs. More particularly, the invention is concerned with determining whether a reservoir, whose approximate geometry and location are known, contains hydrocarbons or water.

Currently, the most widely used techniques for geological surveying, particularly in sub-marine situations, are seismic methods. These seismic techniques are capable of revealing the structure of the subterranean strata with some accuracy. However, whereas a seismic survey can reveal the location and shape of a potential reservoir, it cannot reveal the nature of the reservoir.

The solution therefore is to drill a borehole into the reservoir. However, the costs involved in drilling an exploration well tend to be in the region of £25m and since the success rate is generally about 1 in 10, this tends to be a very costly exercise.

It is therefore an object of the invention to provide a system for determining, with greater certainty, the nature of a subterranean reservoir without the need to sink a borehole.

According to one aspect of the invention, there is provided a method of determining the nature of a subterranean reservoir whose approximate geometry and location are known, which comprises: applying a time varying electromagnetic field to the strata containing the reservoir; detecting the electromagnetic wave field response; and analysing the effects on the characteristics of the detected field that have been caused by the reservoir, thereby determining the content of the

reservoir, based on the analysis.

According to another aspect of the invention, there is provided apparatus for determining the nature of a subterranean reservoir whose approximate geometry and location are known comprising: means for applying a time varying electromagnetic field to the strata containing the reservoir; means for detecting the electromagentic wave field response, and means for analysing the effects on the detected field that have been caused by the reservoir, thereby enabling the content of the reservoir to be determined based on the analysis.

It has been appreciated by the present applicants that while the seismic properties of oil-filled strata and water-filled strata do not differ significantly, their electromagnetic resistivities/ permittivities do differ. Thus, by using an electromagnetic surveying method, these differences can be exploited and the success rate in predicting the nature of a reservoir can be increased significantly. This represents potentially an enormous cost saving.

The technique is applicable in exploring land-based subterranean reservoirs but is especially applicable to submarine, in particular sub-sea, subterranean reservoirs. Preferably the field is applied using one or more stationary transmitters located on the earth's surface, and the detection is carried out by one or more stationary receivers located on the earth's surface. In a preferred application, the transmitter(s) and/or receivers are located on or close to the seabed or the bed of some other area of water. Conveniently, there will be a single transmitter and an array of receivers, the transmitter(s) and receivers being dipole antennae or coils, though other forms of transmitter/receivers can be used. Also, if improved directionality of the emitted field is desirable,

then a plurality of transmitters with phase adjustment can be used.

Electromagnetic surveying techniques in themselves are known. However, they are not widely used in practice. In general, the reservoirs of interest are about 1 km or more below the sea bed. In order to carry out electromagnetic surveying in these conditions, with any reasonable degree of resolution, short wavelengths are necessary. Unfortunately, such short wavelengths suffer from very high attenuation. Long wavelengths do not provide adequate resolution. For these reasons, seismic techniques are preferred.

However, while longer wavelengths applied by electromagnetic techniques cannot provide sufficient information to provide an accurate indication of the boundaries of the various strata, if the geological structure is already known, they can be used to determine the nature of a particular identified formation, if the possibilities for the nature of that formation have significantly differing electromagnetic characteristics. The resolution is not particularly important and so longer wavelengths which do not suffer from excessive attenuation can be employed.

The resistivity of sea water is about 0.3 ohm-m and that of the overburden beneath the sea bed would typically be from 0.3 to 4 ohm-m, for example about 2 ohm-m. However, the resisitivty of an oil reservoir is likely to be about 50 ohm-m. This large difference can be exploited using the techniques of the present invention. Typically, the resisitvity of a hydrocarbon-bearing formation will be 20 to 400 times greater than water-bearing formation.

Due to the different electromagnetic properties of a gas/oil bearing formation and a water bearing formation,

one can expect a reflection of the transmitted field at the boundary of a gas/oil bearing formation. However, the similarity between the properties of the overburden and a reservoir containing water means that no reflection is likely to occur.

The transmitted field may be pulsed, however, a coherent continuous wave with stepped frequencies is preferred. It may be transmitted for a significant period of time, during which the transmitter should preferably be stationary, and the transmission stable. Thus, the field may be transmitted for a period of time from 30 seconds to 60 minutes, preferably from 3 to 30 minutes, for example about 20 minutes. Preferably, the receivers are arranged to detect a direct wave and a wave reflected from the reservoir, and the analysis includes extracting phase and amplitude data of the reflected wave from corresponding data from the direct wave.

The direct wave, which progresses via the sea water and the surface layers of the overburden, will reach the receivers first and will be much stronger than the later reflected waves. In an alternative system, therefore, the direct wave may be suppressed, using known techniques. This means that the receivers used will not require such a large dynamic range.

Preferably, the wavelength of the transmission is given by the formula

$$0.1s \leq \lambda \leq 10s;$$

where λ is the wavelength of the transmission through the overburden and s is the distance from the seabed to the reservoir. More preferably λ is from about 0.5s to 2s. This may be achieved by adopting a transmission frequency

from 0.1 Hz to 1 kHz, preferably from 1 to 50 Hz, for example 20 Hz.

In a preferred regime, a first transmission is made at a first frequency and received by each receiver in a tuned array of receivers, then a second transmission is made at a second frequency and received by the same tuned array of receivers, the receivers being tuned to receive their respective transmission. This would probably be repeated several more times, though it may only be carried out once.

Preferably, the analysis includes comparing the results of the measurements taken with the results of a mathematical simulation model based on the known properties of the reservoir and overburden conditions.

Preferably, the distance between the transmitter and a receiver is given by the formula

$$0.5\ \lambda \leq l \leq 10\ \lambda;$$

where λ is the wavelength of the transmission through the overburden and l is the distance between the transmitter and the first receiver.

Given that the distance s and the geometry of the reservoir will be known from previous seismic surveys, an optimum λ and l would be selected.

Where dipole antennae are used these may be fixed, however, they are preferably adapted antennae which can be tuned for optimum transmission and reception in dependence upon the frequency of the transmission and its wavelength through the overburden. This may be achieved by altering their effective length either by remote controlled relays or by electronic switching systems. In addition, the driving circuit may be tuned in order to increase the

bandwidth.

Preferably, the analysing means is arranged to analyse phase and amplitude.

If a location of interest is considered, a mathematical modelling operation may be carried out. Thus, the various relevant parameters, such as depth and expected resistivities of the various known strata in the overburden are applied to the mathematical model and the expected results are calculated in dependence upon whether a formation under consideration is oil-bearing or water-bearing. The theoretically predicted results can then be compared with the actual results achieved in the field in order to determine the nature of the formation.

The present invention also extends to a method of surveying subterranean measures which comprises; performing a seismic survey to determine the geological structure of a region; and where that survey reveals the presence of a subterranean reservoir, subsequently performing a method as described above.

The invention may be carried into practice in various ways and some embodiments will now be described by way of example with reference to the accompanying drawings, in which:-

Figure 1 is a schematic section of a system in accordance with the invention.

Figure 1 shows a section through a region which has already been the subject of a seismic survey. The geological structure is known and consists of several strata which form an overburden 11 above a reservoir layer 12 and underlying strata 13. The top of the overburden is a seabed 14 above which is, of course, sea water 15.

In order to determine whether or not the reservoir layer 12 is hydrocarbon-bearing, an electromagnetic surveying technique is carried out. A vessel 16 lays a

cable 17 on the seabed 14. The cable 17 includes an electromagnetic transmitter 18 and several receivers in the form of dipole antennae, three of which 21, 22, 23 are shown.

The thickness s of the overburden 11 is known to be 1000 m. The depth of the water is about 800 m, though this is of no particular significance. Under these circumstances, the distance l between the transmitter 18 and the middle antenna 22 is arranged to be 2000 m, i.e. 2s. The distance between adjacent antennae is about 100 m. In all, the length of the cable 17 is likely be about 4000 m.

When the cable 17 is in position on the seabed 14, the transmitter 18 is activated and transmits an electromagnetic field in the form of a wave. The transmission frequency is in the range of about 1 to 30 Hz and the specific value is selected to produce a wavelength λ in the overburden which is approximately equal to s, that is to say, $\lambda \cong 1000$ m. The transmitter 18 is tuned for optimum transmission and the antennae 21-23 are tuned to receive transmissions at $\lambda = 1000$ m. The antennae 21-23 receive a direct wave 24 from the transmitter and also respective reflected waves 25, 26, 27 which are reflected by the reservoir layer 12 if the layer 12 is hydrocarbon-bearing. The received direct wave 24 and received reflected waves 25-27 are analysed and compared with for example the results of forward modelling calculations based on the seismics and typical overburden electrical characteristics and from the results, a judgement can be made as to the nature of the layer 12.

Typically, a frequency of 20 Hz might be selected initially. This would result in a wavelength of 400 m in the sea water and a wavelength of about 1000 m in the

overburden. The wavelength in the layer 12, if hydrocarbon-bearing would be about 5000 m. Under these circumstances, the attenuation would be:

Direct Wave	
Antenna loss	-40dB
Propagation loss	-110dB
Reflected Wave	
Antenna loss	-40dB
Propagation loss	-150dB
Reflection loss	-20dB

The demanded dynamic range of the receiver system will then be 210 dB - 150 dB = 60 dB. By appropriate suppression of the direct wave, this demand will decrease dramatically and the resolution of the reflected signal will possibly be increased.

The transmission would be carried out for several minutes at a continuous power level of perhaps 10 kw.

This procedure is then repeated at a different frequency. This would result in different wavelengths and possibly consequent re-tuning of the antennae system. At a frequency of for example 5Hz, the wavelength in sea water would be 800 m and the wavelength in the overburden, about 2000 m. The wavelength in the layer 12, if hydrocarbon-bearing, would be 10 km. The attenuation would be:

Direct Wave	
Antenna loss	-40dB
Propagation loss	-55dB

Reflected Wave	
Antenna loss	-40dB
Propagation loss	-75dB
Reflection loss	-30dB

The demand for dynamic range of receiver system is now 145 dB - 95 dB = 50 dB.

In a preferred regime, the frequency would be increased stepwise over a range, for example 5 to 20 Hz.

The entire procedure can then be repeated in different locations and at different orientations. It will also be appreciated that by repeating the procedure after a period of production, the change in condition of a reservoir can be determined. This can be of value in assessing the positions in a particular field where hydrocarbons might still be present, and where the well might be depleted.

Claims:

1. A method of determining the nature of a submarine or subterranean reservoir whose approximate geometry and location are known, which comprises: applying a time varying electromagnetic field to the strata containing the reservoir; detecting the electromagnetic wave field response; and analysing the effects on the characteristics of the detected field that have been caused by the reservoir, thereby determining the content of the reservoir, based on the analysis.

2. A method as claimed in Claim 1, in which the field is applied using one or more stationary transmitters located on the earth's surface.

3. A method as claimed in Claim 1 or Claim 2, in which the detection is carried out by one or more stationary receivers located on the earth's surface.

4. A method as claimed in Claim 2 or Claim 3, in which the transmitter and/or receivers are located on or close to the seabed or the bed of some other area of water.

5. A method as claimed in any preceding Claim, in which the transmitted field is in the form of a wave.

6. A method as claimed in any preceding Claim, in which the field is transmitted for a period of time from 30 seconds to 60 minutes.

7. A method as claimed in Claim 6, in which the transmission time is from 3 minutes to 30 minutes.

8. A method as claimed in any of Claims 3 to 7, in which the receivers are arranged to detect a direct wave and a wave reflected from the reservoir, and the analysis includes extracting phase and amplitude data of the reflected wave from corresponding data from the direct wave.

9. A method as claimed in any of Claims 5 to 8, in which the wavelength of the transmission is given by the formula

$$0.1s \leq \lambda \leq 10s;$$

where λ is the wavelength of the transmission through the overburden and s is the distance from the seabed to the reservoir.

10. A method as claimed in any of Claims 5 to 9, in which distance between the transmitter and a receiver is given by the formula

$$0.5\ \lambda \leq l \leq 10\ \lambda;$$

where λ is the wavelength of the transmission through the overburden and l is the distance between the transmitter and the receiver.

11. A method as claimed in Claims 9 and 10, in which, substantially,

$$l = 2s = 2\lambda.$$

12. A method as claimed in any of Claims 3 to 11, in which the transmission frequency is from 0.1 Hz to 1 kHz.

13. A method as claimed in Claim 12, in which the transmission frequency is from 1 to 50 Hz.

14. A method as claimed in any of Claims 3 to 13, in which a first transmission is made at a first frequency and received by each receiver in a tuned array of receivers, then a second transmission is made at a second frequency and received by the same tune array of receivers, the receivers being tuned to receive their respective transmission, the transmitter(s) also being tuned for optimum transmission.

15. A method as claimed in any preceding Claim, in which the analysis includes comparing the results of the measurements taken with the results of a mathematical simulation model based on the known properties of the reservoir and overburden conditions.

16. A method as claimed in any of Claims 8 to 15, which includes suppressing the direct wave, thereby reducing the required dynamic range of the receivers and increasing the resolution of the reflected wave.

17. Apparatus for determining the nature of a subterranean reservoir whose approximate geometry and location are known comprising: means for applying a time varying electromagnetic field to the strata containing the reservoir; means for detecting the electromagnetic wave field response, and means for analysing the effects on the detected field that have been caused by the reservoir, thereby enabling the content of the reservoir to be

determined based on the analysis.

18. Apparatus as claimed in Claim 17, in which the means for applying the field comprises a transmitter and the means for detecting the field comprises an array of receivers.

19. Apparatus as claimed in Claim 18, in which the transmitter and the receivers comprise dipole antennae or coils.

20. Apparatus as claimed in any of Claims 17 to 19, in which there are more than one transmitter.

21. Apparatus as claimed in any of Claims 17 to 20, in which the analysing means is arranged to analyse phase and amplitude.

22. A method of surveying subterranean measures which comprises; performing a seismic survey to determine the geological structure of a region; and where that survey reveals the presence of a subterranean reservoir, subsequently performing a method as claimed in any of Claims 1 to 16 to determine the nature of the reservoir.

Abstract

A system for determining the nature of a subterranean reservoir 12 whose position and geometry is known from previous seismic surveys. An electromagnetic field 24, 25, 26, 27 is applied by a transmitter 18 on the seabed 14 and detected by antennea 21, 22, 23 also on the seabed 14. The nature of the detected reflected waves 25, 26, 27 is used to determine whether the reservoir 12 contains water or hydrocarbons.

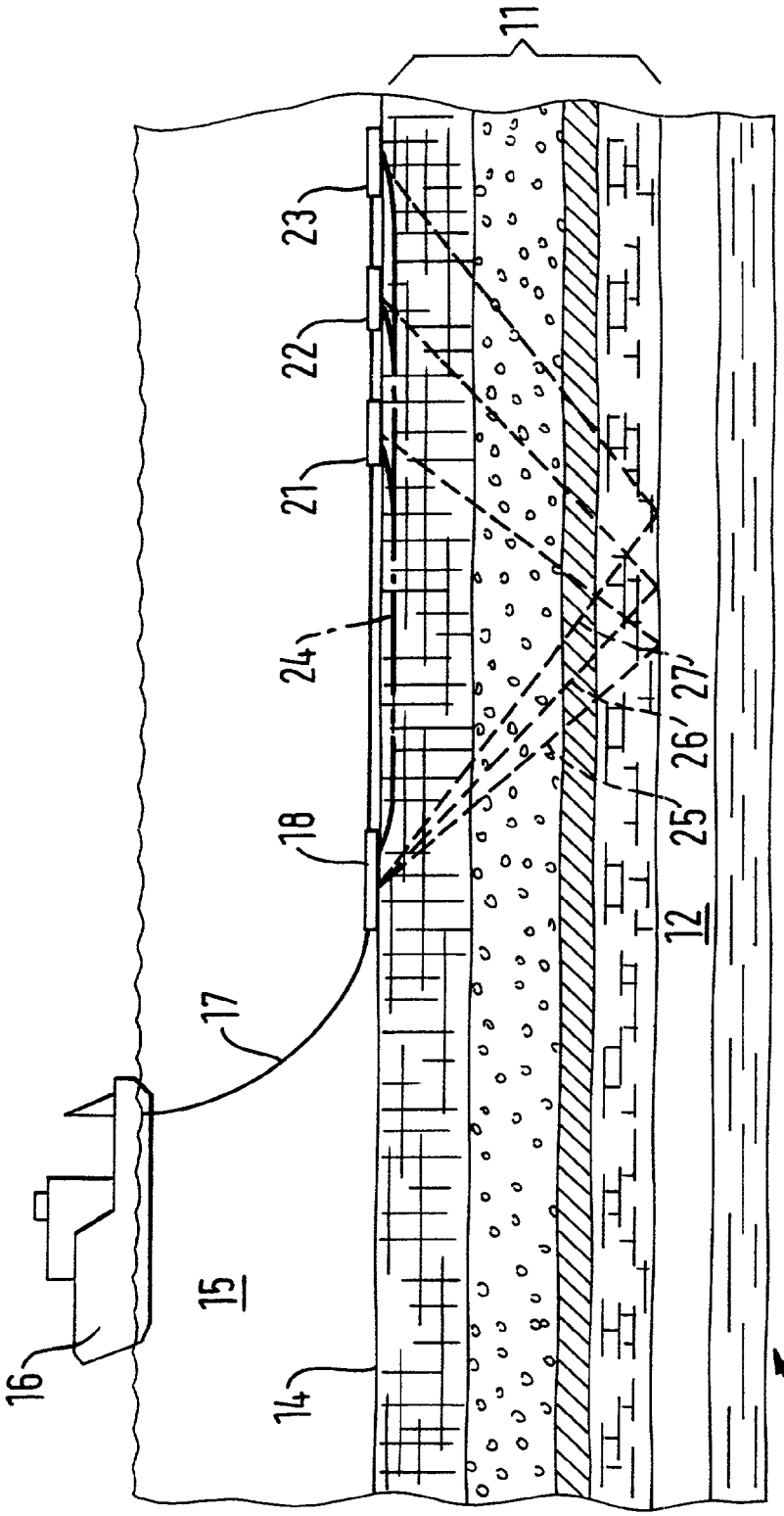

FIG. 1

Attorney Docket No. 1101.99US01

COMBINED DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled METHOD AND APPARATUS FOR DETERMINING THE NATURE OF SUBTERRANEAN RESERVOIRS, the specification of which is attached hereto unless the following is checked:

[X] The specification was filed on February 22, 2001 as United States Application Number or PCT International Application Number 09/763,446 and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, § 119(a)-(d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)		Priority Claimed	
PCT/GB99/02823	WO	26 August 1999	Yes
(Number)	(Country)	(Day/Month/Year Filed)	(Yes/No)
9818875.8	GB	28 August 1998	Yes
(Number)	(Country)	(Day/Month/Year Filed)	(Yes/No)

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below.

_____ _____
(Application Number) (Filing Date)

_____ _____
(Application Number) (Filing Date)

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application(s) in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

(Application Number)	(Filing Date)	(Status - patented, pending, abandoned)
(Application Number)	(Filing Date)	(Status - patented, pending, abandoned)

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

James H. Patterson (30,673), John F. Thuente (29,595), Wm Larry Alexander (37,269), Kimberly K. Baxter (40,504), Eric H. Chadwick (41,664), Randall T. Skaar (42,151), Douglas J. Christensen (35,480), John F. Dolan (45,382), Curtis B. Herbert (45,443), Michael A. Bondi (39,616), Paul C. Onderick (45,354), Brad D. Pedersen (32,432), Scott G. Ulbrich (P48,005), and David A. Olsen, (46,969).

14 -

Address all telephone calls to: James H. Patterson at telephone number (612) 349-5741

Address all correspondence to: Customer No. 24113
James H. Patterson
Patterson, Thuente, Skaar & Christensen, P.A.
4800 IDS Center, 80 South 8th Street
Minneapolis, Minnesota 55402-2100

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

1-00 Terje Eidesmo
Full name of sole or first inventor (given name, family name)

Terje Eidesmo
Inventor's signature

12 - June - 2001
Date

Ranheim, Norway NOX
Residence (City and either State or Foreign Country)

Norway
Citizenship

Markapl. 5, 7054 Ranheim, Norway
Mailing Address

2-00 Svein Ellingsrud
Full name of second joint inventor, if any (given name, family name)

Svein Ellingsrud — 12 - June - 2001
Second Inventor's signature — Date

Trondheim, Norway NOX — Norway
Residence (City and either State or Foreign Country) — Citizenship

Tyholt alle 9A, 7052 Trondheim, Norway
Mailing Address

3-00 Fan-Nian Kong
Full name of third joint inventor, if any (given name, family name)

Fan-Nian Kong — 30 May 2001
Third Inventor's signature — Date

Oslo, Norway NOX — Norway
Residence (City and either State or Foreign Country) — Citizenship

Langbolgen 71, 1150, Oslo, Norway
Mailing Address

4-00 Harald Westerdahl
Full name of fourth joint inventor, if any (given name, family name)

Harald Westerdahl — 30 May -2001
Fourth Inventor's signature — Date

Dal, Norway NOX — Norway
Residence (City and either State or Foreign Country) — Citizenship

Haugeras, 2072 Dal, Norway
Mailing Address

5-00 Stale Johansen
Full name of fifth joint inventor, if any (given name, family name)

Stale Johansen — 15-june-2001
Fifth Inventor's signature — Date

Melhus, Norway NOX — Noway
Residence (City and either State or Foreign Country) — Citizenship

Loddgardstroa 27B, 7224 Melhus, Norway
Mailing Address